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To cite this article: Ahmad *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **528** 012071

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Analyze of mitigation waste in reconditioning process of Iron Drum with Lean Six Sigma (Case study at PT Mulya Adhi Paramita)

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Abstract. PT. Mulya Adhi Paramita is a chemical company that focuses on the distribution of chemicals, but also performs the process of reconditioning used iron drums. In the process of reconditioning drum is still found some waste, for that this research using lean six sigma concept which aims to reduce waste on drum recondition process. This research uses DMAIC stage and using Waste Assessment Model method with the result of 2 biggest waste identification is waste motion and defect which will become priority improvement, using Defect Per Million Opportunity to know sigma level that is equal to 3,77 sigma, Value Stream Mapping with percentage result PCE on CVSM of 16.31%; Process Activity Mapping result is value added time of 60.22 minutes, non value added time of 9.74 minutes, and necessary non value added time of 21.88 minutes. After performing the improvement implementation can be seen the result is the increase in PCE on FVSM of 21.5%, decreased percentage defect by 0.72% and DPMO with sigma level of 3.81 sigma

Keywords: Iron drum, Waste Assessment Model, Value Stream Mapping, Process Activity Mapping, Failure Mode and Effect Analysis

1. Introduction

The development of the chemical industry in Indonesia is rapidly grown. It can be seen from the increasing distribution of chemicals by the small to large business sector in mostly all areas of Indonesia which use chemicals as main core business. In the distribution of the chemicals, occasionally requires special packaging, depends on the characteristics of chemicals. One of packaging tools that has been used often is the drum. Drum is unreactable material which perfectly fit to load the chemicals for a long time.

PT. Mulya Adhi Paramita (MAP) is a company focusing on the distribution of liquid or solvent chemicals. In the process of packaging the product, MAP uses the reconditioned iron drum that made by company itself in order to save production costs.

In the real conditions in the reconditioning process drum has still found problems with high occurance, which leads to be wasted. The bunches of waste can be caused by various factors such as humans, machines, methods, and others. The impact of these problems could impact to the high cost of the company. Based on these problems, it will be necessary to conduct research with a special study to reduce waste in MAP. One of the methode that been using in this research with oncoming lean six sigma include DMAIC phase, waste assessment model method, and value stream mapping.



The research goals are about to identify the waste that occurs in the process of reconditioning the drum, analyzing the factors of the waste, and provide alternative solutions that need to be done in order to reduce waste. Research is only done on recondition drum process at MAP, for improvement focused only on 2 types of waste that is dominant based on WAM method, and product defect data used in research is data in 2017.

2. Methods

2.1. Lean Six Sigma

Lean and Six Sigma can be defined as business philosophy, systemic and systematic approaches to identify and eliminate waste or non-added activities through continuous radical (continuous improvement) to achieve sigma-level work, by streaming products (materials, work in process, output) and information using pull system (pull system) from internal and external customers for excellence and perfection produce only 3.4 defects for every single operation 3.4 DPMO (defect per million of opportunities).

2.2. Value Stream Mapping

Value stream mapping is a visual process mapping in which there is a flow of information and material flow in order to prepare better methods and performance [2]. The purpose of value stream mapping is to identify and eliminate waste sources by applying proposed-state value streams that can become a reality in the near term. The goal is to build a production chain in accordance with the concept of lean that each process is directly connected to the demand of the customer either with continuous flow or with pull system and every process cultivated as optimal as possible to produce in accordance with what the customer requested with the time and amount.

2.3. Process Activity Mapping

Process Activity Mapping is used to identify lead time and productivity of both physical product flow and information flow, not only within the scope of the company or also in other areas of the supply chain. The basic concept of this tool is to map each stage of activity that occurs from operations, transportation, inspection, delay and storage, then grouping into types of activities that begin with value adding activities, non value added activities and non value adding activities. The purpose of this mapping is to help understand the flow of processes, to identify waste, to identify whether a process can be rearranged more efficiently, to identify improvements in value added flows.

2.4. Waste Assessment Model

The Waste Assessment Model is a model developed to simplify the search for waste issues and identify to eliminate waste. This model illustrates the relationship between seven waste (O: overproduction, P: Processing, I: Inventory, T: Transportation, D: Defect, W: Waiting, and M: Motion).

2.5. Waste Relationship Matrix (WRM)

Waste Relationship Matrix (WRM) is a matrix used to analyze measurement criteria. The line on the matrix shows the effect of a particular waste on the other 6 wastes, while the column in the matrix shows the waste that is affected by other waste. The diagonal of the matrix is placed with the highest relationship value and by default, each type of waste will have a principal relationship with the waste itself.

2.6. Waste Assessment Questionnaire (WAQ)

Waste Assessment Questionnaire (WAQ) is used to identify and allocate waste that occurs on the production line. The assessment questionnaire consisted of 68 different questions, where the questionnaire was known for the purpose of determining waste

2.7. Research Methodology

The following stages of methodology in conducting research at PT. Mulya Adhi Paramita can be seen in Figure 1. This research was conducted with many methods, from data collecting until data processing. Using questionnaire for FMEA and direct measure for timing process in Current Value Stream Mapping and Future Value Stream Mapping, in order to make the whole process's result with high efficiency and effective.

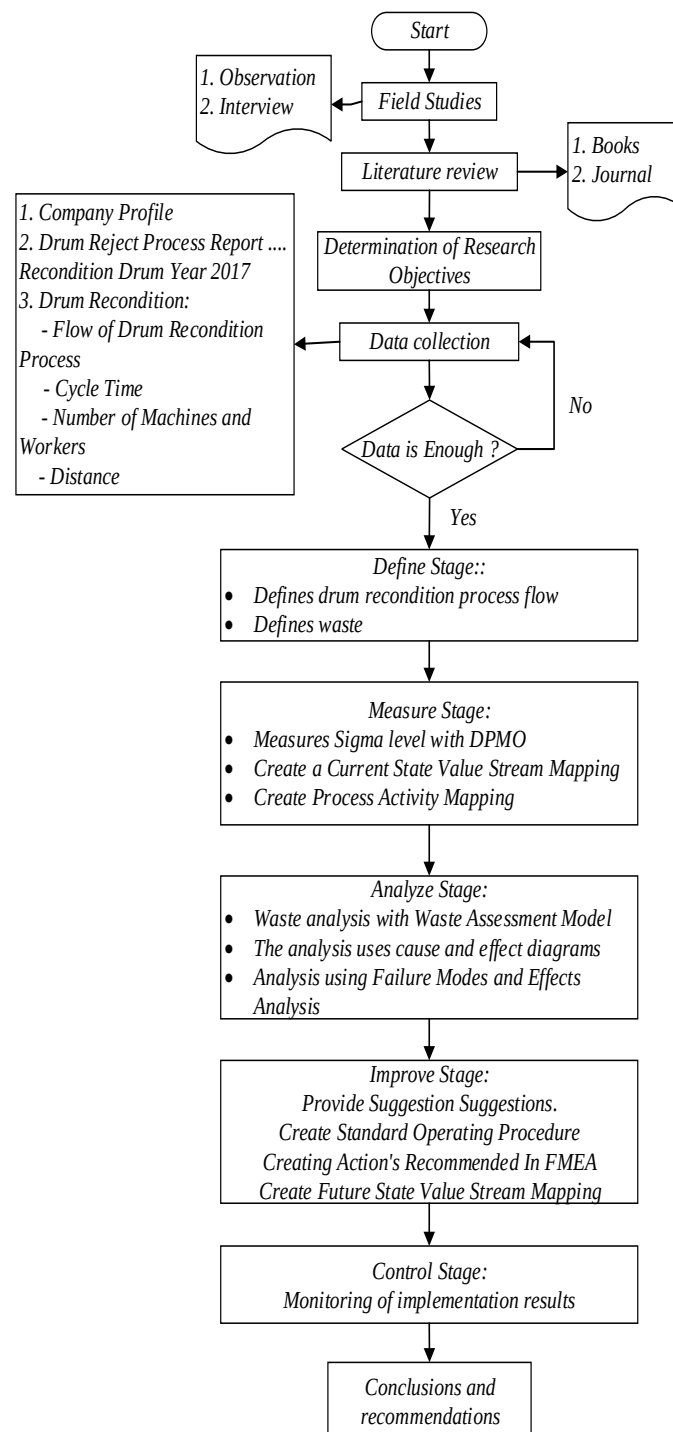


Figure 1. Flowchart of Research Methodology

3. Results and Discussion

3.1. Define

Define stage is the stage of stipulating the target of six sigma project which confirmed that drum recondition process with drain recondition process with stages of drain recondition process starting from drum used at its storage then goes to recondition process until product is done at its place of storage. The scheme process can be seen in Figure 2.

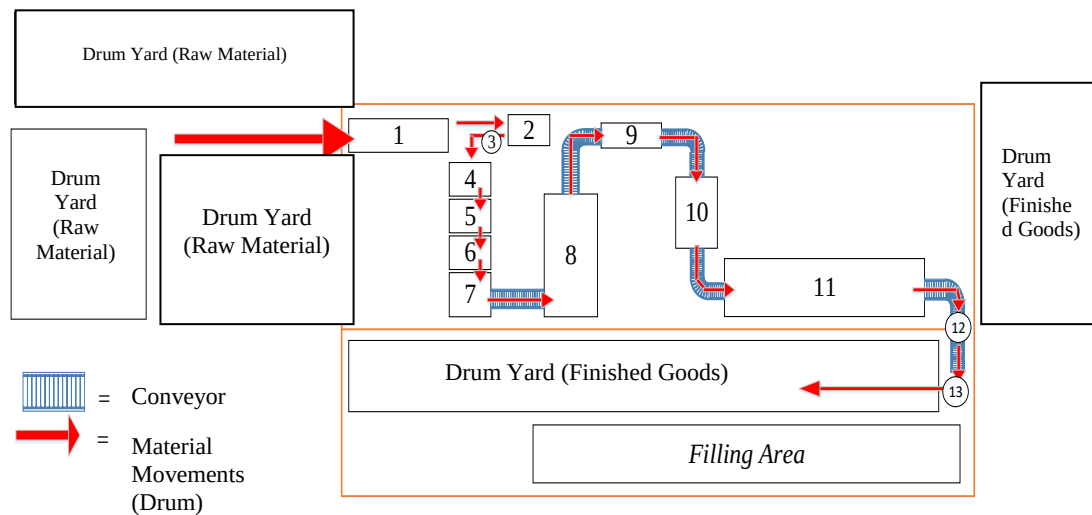


Figure 2. Flow of Drum Recondition Processes

Further defining the waste along with some of which are contained in the process of reconditioning iron drums in MAP, namely:

Waste Motion

Waste motion is type of waste that occurs due to the movement or machine that does not add value to goods and services for customers, but only increase the cost and time. Waste motion that occurs in the process of reconditioning drums, namely:

- In storing the used drum on the drum yard, the worker must create a drum row and drum up the stratum.
- The worker does not move the drum defect on the storage area so as to move the recurrent drum defect in the drain recondition area for blocking the movement and transfer of the WIP drum.
- Workers put the drums that defect on the drum yard in vain so that it can mix with the former drum. This resulted in drum defect should be returned to the suppliers to be transferred again in the process of reconditioning because workers can Space considerations not distinguish the former drum raw material and drum defect.
- The process of moving the drum into a storage place that is far enough distance and the number of manually.

3.2. Measure

The measure stage is the measurement stage to make it easier to know the current level of performance by using Defect Per Million Opportunity, Current Value Stream Mapping, and Process Activity Mapping. Here is a calculation of DPMO performed to determine the level of Sigma using drum defect drum process data in 2017 and Sigma value of 3.77 Sigma which means that defect is enough to be resolved but still needed further analysis. The results of DPMO calculations can be seen in Table 1.

Table 1. Defect per million opportunities

Information	Results
Defect	44.874 drum
Unit	637.993 drum
Opportunities	6
Defect per unit	0,07033
Defect per Opportunity	0,011722699
DPMO	11.722,69
Sigma level	3,77 Sigma

Furthermore, the mapping of Current Value Stream Mapping to know the flow of information relating to the process of reconditioning drums, stages of iron drain recondition process from used drums to finished products for consumers, and Value Added Time of 18.92 minutes and Non Value Added Time of 97.06 minute, Lead Time of 115.98 minutes, and the percentage of Process Cycle Efficiency (PCE) of 16.31% so that PCE <30% then the drain recondition process does not include lean.

Then create Process Activity Mapping is used to determine the proportion of activities or activities including Value Added (VA) and Non Value Added (NVA) and identify waste in the value stream and optimize the process so that more efficient and effective. Based on the activity mapping tool process it can know the values and activities that can be seen in Table 2 and Table 3. Total activities of 46 activities that have a total time of 91.847 minutes.

Table 2. Summary Process Activity Mapping By Value

Information	Number of Activities	Total Time (minutes)
Value Added	14	60,224
Non Value Added	4	9,741
Non Value Added Necessary	28	21,8826
TOTAL	46	91,8476

Table 3. Summary of Activity Mapping by Activity

Activities	Number of Activities	Total Time (minutes)	Percentage (%)
Operation	23	63,549	69,19
Transportation	16	18,230	19,85
Inspection	3	0,328	0,36
Storage	0	0	0
Delay	4	9,741	10,61
TOTAL	46	91,847	100

Based on the above table it can be seen that in the process of reconditioning drum for the proportion of operation time has the largest time that is for 63 minutes with a percentage of 69% of the total time. It can be concluded that the waste that occurs in the drain recondition process is only found in 4 activities that are non value added which is classified as Delay with 9.7 minutes of total time total of 91.8 minutes, this means the process of reconditioning drum in the current condition is quite efficient.

3.3. Analyze

The analyze stage is the stage to analyze the most dominant problem of waste analysis and the causal factors of waste in the drain recondition process. The process of waste analysis using waste assessment

model method by conducting discussion with recondition drum workers to give an understanding about WRM and WAQ method, then the WRM and WAQ questionnaires were given to 5 correct reconditioning drum workers, 1 supervisor, 2 leader and 2 staff so they are able to answer the questionnaire correctly. The following is the result of the waste analysis process so that the final result is the rank of waste that can be seen and Figure 3.

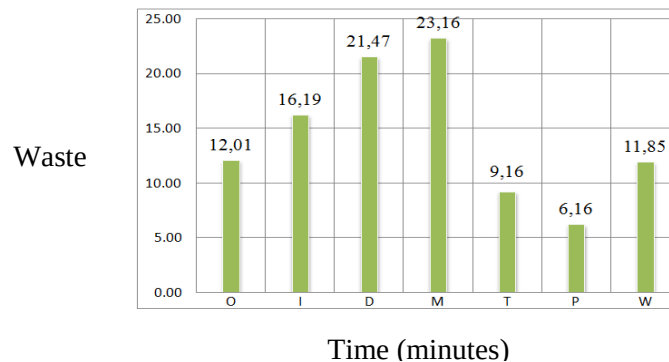


Figure 3. Rank Result of Waste Assessment Calculation

Based on the graph can be known waste with the greatest value is the motion of 23.16; defect of 21.47; inventory of 16.19; over production of 12.01; transportation of 9.16; waiting for 11.85, and process of 6.16. So that can be known 2 biggest waste which will become priority of repair is waste motion and defect.

3.4. Improve

The improvement stage is an improvement stage by determining the repair solution related to the causal factors that have been found in the analyze phase so that it can reduce the waste on the drain recondition process. The following suggestions for improvement are Future State Value Stream Mapping

Future State Value Stream Mapping is a condition of value stream mapping after the implementation of the improvement so that it can show the percentage comparison of process cycle efficiency before improvement that is 16.31% to 21.5% after implementation.

3.5. Control

At this stage the authors will implement proposed suggestions for improvements, Standard Operating Procedures, and Actions Recommended that have been made in the process of reconditioning used iron drums in PT. Mulya Adhi Paramita to overcome waste motion and defect in order to minimize waste in accordance with the purpose of this study. The result of the implementation for 10 working days is the reduction of defect percentage of 0.72% which means the implementation of the implementation is quite successful which can be seen in Table 4.

Table 4. Percentage of Defect Comparison

Before Implementation	After Implementation
Percentage defect = 7,03%	Percentage defect = 6,31 %
The existence of a decrease in magnitude 0,72 %	

DPMO calculation is then performed again using data defect after implementation for 10 working days. DPMO calculation results can be seen on Table 5.

Table 5. DPMO After Implementation

Information	Results
Defect	1727 drum.
Unit	27.372 drum.
Oportunities	6
Defect per unit	0,0630
Defect per Opportunity	0,01051561
DPMO	10515,61
Sigma Level	3,81 Sigma

Based on the above table it can be seen there is an increase in sigma value of 0.04 from 3.77 sigma to 3.81 sigma. This means that the implementation has done a good enough impact in improving the performance results of the drain recondition process.

4. Conclusion

The following conclusions can be found after doing this research, namely:

1. Waste contained in recondition drum at PT. Mulya Adhi Paramita based on the identification of the Waste Assessment Model with the second largest ranking of waste motion and waste defect such as drum failed paint, drum leak, drum in the water or wet, the drum of the inner oil and drum in the other material.
2. The factors causing waste motion are basically due to poor storage and other inefficient activities. While waste defect caused by various factors starting from human, machine, environment, and storage.
3. A repair solution used to reduce waste occurring in the reconditioning process of drums, especially waste motion and defect is to provide suggestions of improvements, rack design for drum storage, standard operating procedure, and action recommended on FMEA.

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